A COMPARISON OF FACTORS AFFECTING THE DEVELOPMENT OF THREE SPECIES OF MOSQUITOES, *AEDES* (*PSEUDOSKUSEA*) *CONCOLOR* TAYLOR, *AEDES* (*STEGOMYIA*) *AEGYPTI* LINNAEUS AND *CULEX* (*CULEX*) *FATIGANS* WIEDEMANN.

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Introduction.

In four previous papers by the author (1936, 1938, 1941*a* and 1941*b*) the effect of salts in solution, pH values, and temperature on certain of the above species have been presented. The following paper gives the results of some experiments which fill gaps in the previous work, and presents a summary of the effect of the various factors on the three species.

Laboratory Experiments.

The technique of breeding, maintaining pH values, etc., was similar to that described in previous papers. The symbol S‰ indicates grams of salts per 1,000 gm. of water.

Table 1.

First instar larvae of A. aegypti *hatched in distilled water and transferred within 12 hours to tap-water of various pH values, plus food. Twenty larvae in each experiment. Constant temperature, 80° F.*

No. of Experiment.	pH Values.	No. of Adults.	Larval and Pupal Period in Days.	Mean per cent. Adults.
1	6·8 to 7·2	20	7 to 11	99
2		20		
3		20		
4		20		
5		19		
6	3·6 to 4·2	11	10 to 14	59
7		10		
8		15		
9		12		
10		11		
11	9·2 to 9·5	20	10 to 12	97
12		19		
13		18		
14		20		
15		20		

Table 2.

First instar larvae of A. concolor *hatched in sea-water and transferred within 12 hours to sea-water of various pH values, plus food. Twenty larvae in each experiment. Constant temperature, 70° F.*

No. of Experiment.	pH Values.	No. of Adults.	Larval and Pupal Period in Days.	Mean per cent. Adults.
1	4·0 to 4·2	14	21 to 33	77
2		16		
3		17		
4		15		
5		15		
6	7·8 to 8·2	19	16 to 22	89
7		20		
8		20		
9		16		
10		14		

TABLE 3.

First instar larvae of A. aegypti *hatched in distilled water and transferred within 12 hours to various types of water, plus food. Twenty larvae in each experiment. Constant temperature, 80° F.*

No. of Experiment.	Comp. of Water.	No. of 4th Instar Larvae.	No. of Pupae.	No. of Adults.	Mean per cent. Adults.
1	Distilled water	—	—	20	99
2		—	—	20	
3		—	20	19	
4		—	—	20	
5		—	—	20	
6	Distilled water plus sea-water S‰ 10	20	19	19	96
7		20	20	20	
8		20	20	20	
9		20	19	18	
10		20	19	19	
11	Distilled water plus sea-water S‰ 13	0	—	—	0
12		0	—	—	
13		0	—	—	
14		0	—	—	
15		0	—	—	

TABLE 4.

Pupae of A. aegypti *bred in tap-water S‰ 0·06, and transferred within 12 hours of pupation to saline water. Twenty larvae in each experiment. Constant temperature, 80° F.*

No. of Experiment.	Comp. of Water.	No. of Adults.	Mean per cent. Adults.
1	Sea-water S‰ 35	20	100
2		20	
3		20	
4		20	
5		20	
6	Sea-water plus salts S‰ 70	20	99
7		19	
8		20	
9		20	
10		20	

TABLE 5.

General summary of preceding work.

Factors.	*A. concolor.*	*A. aegypti.*	*C. fatigans.*
Tap-water, S‰ 0·06	+	+	+
Distilled water, S‰ 0	−	+	+
Diluted sea-water, S‰ 10	+	+	+
Diluted sea-water, S‰ 13	+	−	−
Sea-water, S‰ 35	+	−	−
Sea-water, S‰ 70	+	−	−
Distilled water plus NaCl, S‰ 0·1 or 0·05	+	+	+
Distilled water plus NaCl, S‰ 0·025	−	+	+
Distilled water plus KCl, $CaCl_2$, etc., S‰ 0·1	−	+	+
pH 6·8	+	+	+
pH 8·2	+		
pH 9·5		+>P	+>*F*
pH 4·2	+>P	+>P	+>P
Tap-water, S‰ 0·06, 70° F.	+	+	+
Tap-water, S‰ 0·06, 80° F.	−	+	+
Sea-water, S‰ 35 and 70, 80° F.	+	−	−
Diluted sea-water, S‰ 5 (oviposition)	+0	−0	−0
Diluted sea-water, S‰ 10 (oviposition)	−0	−0	−0

In Table 1 for *A. aegypti*, pH values of 6·8 to 7·2 represent those obtained in normal tap-water in the control series. If the pH of the water is maintained at 9·2 to 9·5 the developmental period is slightly lengthened, but the total percentage of adults is not affected. When the pH is lowered to 3·6 to 4·2 the developmental period is again somewhat lengthened, but a significant reduction in the number of adults occurs.

In Table 2 for *A. concolor* pH values of 7·8–8·2 are those occurring in normal sea-water plus food. When this sea-water is maintained at 4·0 to 4·2 by the addition of acetic acid, the percentage of adults is not significantly affected, but the period of development is considerably extended.

Table 3 shows that *A. aegypti* can develop normally in distilled water, or diluted sea-water of a salinity of 10 gm. per thousand, but is killed in water of S‰ 13. These results agree with those obtained by Wigglesworth (1938).

Table 4 shows that pupae of *A. aegypti* are not affected in any way by salinities of 35 gm. or 70 gm. per thousand, if transferred from tap-water a few hours after pupation. Similar results were obtained with pupae of *Culex fatigans* (Woodhill, 1938).

Table 5 gives a complete summary of the previous work with the three species. The sign + indicates that normal development takes place, – that no development takes place or a high mortality occurs, >P indicates that the developmental period is prolonged, –0 indicates that the species shows an oviposition preference for distilled water as compared with the salinity given in the table, and +0 that there is no preference for distilled water as against the salinity listed.

Summary.

Of the three species *A. concolor* is restricted entirely to salt-water rock pools at or near high-tide mark, *C. fatigans* is a domestic species which breeds in artificial containers or ground water, with a preference for foul water, while *A. aegypti* breeds only in artificial containers or occasionally in tree holes, near human dwellings, and prefers fairly clean water. From Table 5 it will be seen that *A. aegypti* and *C. fatigans* will develop in distilled water and in salt-water up to S‰ 10, while *A. concolor* will not develop in distilled water but will breed normally in sea-water up to S‰ 70. In addition the first two will breed in tap-water S‰ 0·06 at 80° F., while a heavy mortality occurs in *A. concolor* under those conditions. *A. aegypti* and *C. fatigans* show a distinct oviposition preference for distilled water as compared with water of S‰ 5, while *A. concolor* does not differentiate between these two waters. The difference in oviposition responses is even more marked with water of higher salinity, as shown in a previous paper. (Woodhill, 1941*a*.) All three species will develop through a considerable range of pH values, though the period of development is somewhat lengthened with very high or very low values. The pupae of all three species are not affected by salinities up to S‰ 70.

These marked physiological differences readily explain why *A. aegypti* and *C. fatigans* do not breed in the same type of water as *A. concolor*, but the factors which prevent *A. concolor* from breeding in freshwater pools, swamps, or artificial containers are not yet apparent, and require further investigation.

References.

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